FPM File Copy.
Mailing list enclosed.

Northeastern Area State & Private Forestry

P-72-4

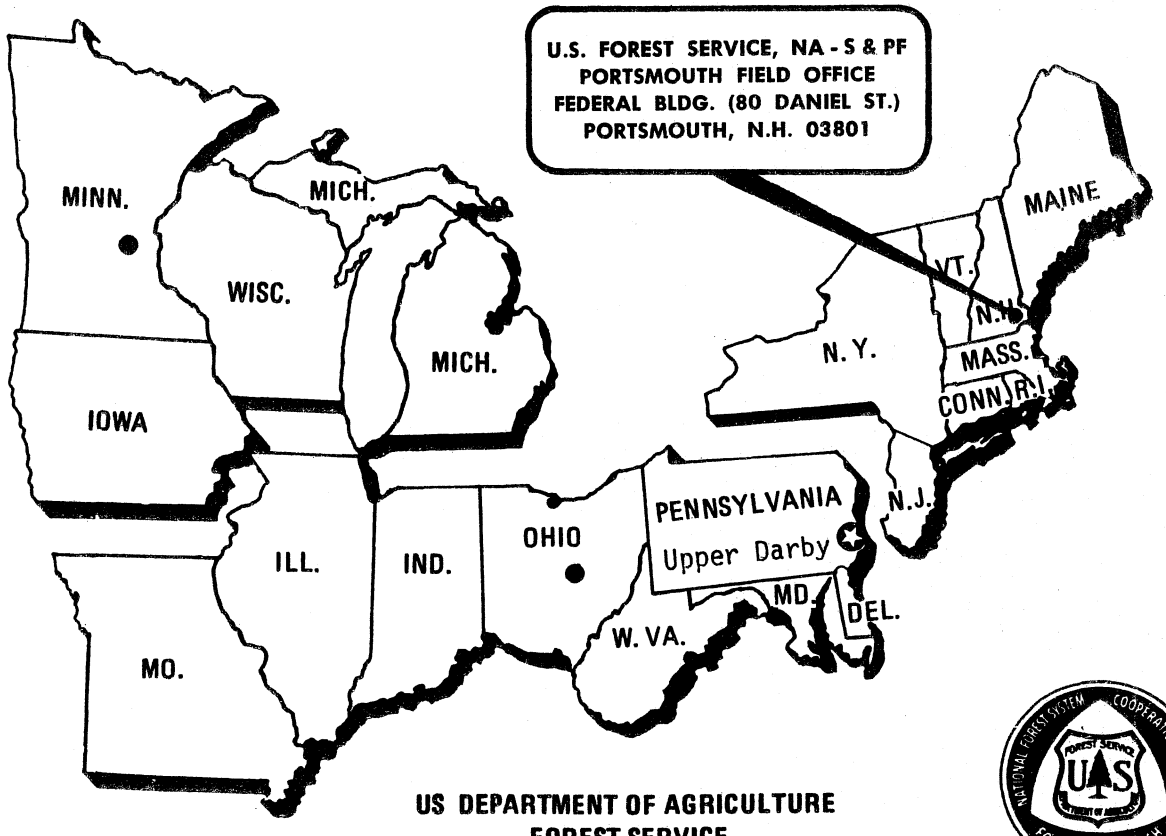
5200

EFFECTS OF INUNDATION ON TREES

MARCH 1972

BY

TERRY A. TATTAR



US DEPARTMENT OF AGRICULTURE
FOREST SERVICE

LIST OF DISTRIBUTED COPIES OF P-72-4

10 - Keith Grest, Resource Planning
1 - Richard K.McHenry, USFS, St. Paul, Minn.
1 - Henry Baldwin, Franklin Pierce College
1 - David Dupee, Corps of Engineers
1 - John Wm. Leslie, Corps of Engineers
1 - Sargent Goodhue, State of N.H. Resources & Economic Development
1 - Mr. Donald Wirth, N. E. Utilities
10 - Upper Darby
1 - Ketchum
1 - Delaware
1 - St. Paul
1 - Murray

EFFECTS OF INUNDATION ON TREES

Terry A. Tattar

This report is a review of literature on the effects of inundation on trees. It was prepared at the request of Keith Grest of our Resource Planning Group. Baldwin (1962) has written a comprehensive literature review on inundation and most of his conclusions are still valid. This report was arranged primarily to update the literature on inundation.

The author wishes to express his thanks to Keith Grest and Alfred Darrach, Resource Planning for supplying him with lists of literature and reprints on inundation which made this report possible. He also wishes to thank the U. S. Army Corps of Engineers and the New Hampshire Department of Natural Resources for their assistance.

LITERATURE REVIEW

The effects of natural inundation on forests were noted by early foresters. Flood control projects, which have become more numerous in the past fifty years, have resulted in various degrees of inundation to trees. The detrimental effects of some forms of inundation became a concern to forest and recreation managers.

Most of the early studies, such as that done by the Corps of Engineers (1955), consisted of describing the effects of inundation on particular sites. These studies were done with uncontrolled inundation and the results varied considerably between studies. Some efforts were made to investigate the effects of inundation on seedlings under controlled conditions in the laboratory or greenhouse.

Baldwin (1962) has conducted an extensive review of much of this early work. Some of his conclusions are: (i) trees can grow in water impoundment areas that are not flooded permanently, (ii) most flooding in the Northeast occurs during the dormant season causing little injury, (iii) moderate increase in soil moisture may improve growth (iv) trees could replace agricultural crops which could not grow in areas subject to periodic flooding, and (v) remove trees intolerant to flooding such as sugar maple, Acer saccharum, and beech, Fagus grandifolia, when doing silvicultural work in areas subject to flooding.

Other researchers have investigated aspects related to inundation, such as effects of growth in saturated soil, adaptations of trees to inundation, management of periodically inundated areas, seasonal effects of inundation, and effects of flooding on species composition. Literature on each of these topics will be reviewed under separate headings.

Effects of Saturated Soil on Tree Growth

Hosner and Leaf (1962) have listed bottomland tree species according to their root and shoot growth while in saturated soil. They list as tolerant: tupelo gum, Nyssa aquatica, pumpkin ash, Fraxinus profunda, black willow, Salix nigra, and green ash, F. pennsylvanica; as intermediate; pinoak, Quercus palustris, eastern cottonwood, Populus deltoides, sycamore, Platanus occidentalis,

boxelder, Acer negundo, red maple, A. rubrum, and silver maple, A. saccharinum; and as intolerant: American elm, Ulmus americana, red gum, Liquidambar styraciflua, hackberry, Celtis occidentalis, and sugarberry, C. laevigata.

Miller and Maki (1957) worked with pond pine (Pinus serotina) on pocosin (wet upland bogs) and showed improved drainage could greatly increase growth. Walker, et al., (1961) obtained similar results with slash pine (P. elliottii) and loblolly pine (P. taeda). Stoeckeler (1965) has shown that roads through swamps in northern United States and Canada can become dams unless adequate drainage through the roads is provided. These swamps cause soil water levels to rise on the uphill side of the road resulting in mortality and poor growth of trees over a large area. He showed that construction of adequate drainage in the uphill area and through the road would alleviate the problem.

Adaptations to Inundation

Hosner (1959) found that eastern cottonwood, (Populus deltoides), green ash, (Fraxinus americana), and sycamore, (Platanus occidentalis), adapted to inundation by the production of adventitious roots near the soil surface. Hosner and Boyce (1962) showed that trees tolerant to inundation have roots that can grow under low aeration and have drought resistant characteristics on their leaves and stems.

Hook, et al., (1967) found that roots of swamp tupelo (Nyssa sylvatica var. biflora) had made physiological adaptations to growing in low amounts of oxygen. The rhizosphere of flooded roots was oxidized by the production of lactic acid and ethanol, and anaerobic respiration was accelerated. The roots also had high CO_2 tolerance, and oxygen diffusion into the roots was facilitated by a decreased formation of corky tissues.

Management of Periodically Flooded Forests

Hosner and Leaf (1962) found that many of the inundation tolerant species actually grow faster in saturated soil than well drained soil. Broadfoot (1967) found that shallow water impoundments in Mississippi could actually increase the growth rate of cottonwood, green ash, and

sweet gum. In this study, winter and spring rainfall were impounded until July 1st. Burton (1971) found that flooding of loblolly pine for 7 weeks during the dormant season yielded the best growth, but longer periods of inundation retarded growth.

Effects of Flooding on Species Composition

Lawrence (1939) showed how inundation had affected the speciation along the Columbia River, and Hosner (1959) found similar results with bottomland species in Illinois. Bedinger (1971) demonstrated that changes in tree species uphill from a river could be correlated to frequency of inundation. Little, et al., (1958) indicated that inundation of areas by salt-water may limit the distribution of loblolly pine.

DuBarry (1963) postulated that the inability of seeds to germinate underwater may affect regeneration by certain species in periodically inundated areas. Similar conclusions were made by Hosner (1958) on the basis of seedling mortality to flooding.

Seasonal Effects of Inundation

Williston (1962) has shown that most loblolly pine seedlings could endure 32 days complete submergence while dormant but could only tolerate 12 days submergence during the growing season. McAlpine (1961) has found yellow poplar seedlings more tolerant to flooding during dormant periods.

LITERATURE CITED

Anonymous. 1955. Timber protection in reservoirs. Project CW-515, New Orleans District, U.S. Army Corps of Engineers. 44p. 9 Tab., 2 Fig.

Baldwin, H. I. 1962. The effect of flooding on trees. Text of paper given to Northern New England Academy of Science 12p.

Broadfoot, W. M. 1967. Shallow-water impoundment increases soil moisture and growth of hardwoods. Soil Sci. Soc. Amer. Proc. 31:562-564.

Burton, J. D. 1971. Prolonged flooding inhibits growth of loblolly pine seedlings. U.S. Forest Service Res. Note SO-124. 4p.

DuBarry, A. P. 1963. Germination of bottomland tree seed while immersed in water. J. Forestry 61:225-226.

Hook, D. D., C. L. Brown, and P. P. Kormanik. 1971. Inductive flood tolerance in swamp tupelo (Nyssa sylvatica var. biflora) (Walt.) Sarg. J. Exp. Bot. 22: 78-87.

Hosner, J. F. 1958. The effects of complete inundation upon seedlings of six bottomland tree species. Ecology 39:371-373.

Hosner, J. F. 1959. Survival, root, and shoot growth of six bottomland tree species following flooding. J. Forestry 57: 927-928.

Hosner, J. F. 1960. Relative tolerance to complete inundation of fourteen bottomland tree species. Forest Sci. 6:246-251.

Hosner, J. F. and S. G. Boyce. 1962. Tolerance to water saturated soil of various bottomland hardwoods. Forest Sci. 8:180-186.

Hosner, J. F. and A. L. Leaf. 1962. The effect of soil saturation upon the dry weight, ash content, and nutrient absorption of various bottomland tree seedlings. Soil Sci. Soc. Amer. Proc. 26:401-404.

Lawrence, D. B. 1939. Some features of the Columbia River gorge with special reference to asymmetry in forest trees. Ecol. Monog. 9:217-259.

Little, S., J. J. Mohr, and L. L. Spicer. 1958. Salt-water storm damage to loblolly pine forests. J. Forestry 56: 27-28.

McAlpine, R. G. 1961. Yellow-poplar seedlings intolerant to flooding. J. Forestry 59:556-558.

Miller, W. D. and T. E. Maki. 1957. Planting pines in pocosins. J. Forestry. 55:659-663.

Stoeckeler, J. H. 1965. Drainage along swamp forest roads. J. Forestry. 63:772-776.

Walker, L. C., R. L. Green, and J. M. Daniels. 1961. Flooding and drainage effects on slash pine and loblolly pine seedlings. Forest Sci. 7:2-15.

Williston, H. L. 1962. Loblolly seedlings survive twelve days submergence. J. Forestry 60:412.